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The angle the tangent makes with the radius vector is $\rho(d\theta/d\rho)$, which is often used in the same way as dy/dx; for instance, in trajectories, etc.

Also solved by *G. B. M. ZERR*, and *J. SCHEFFER*.

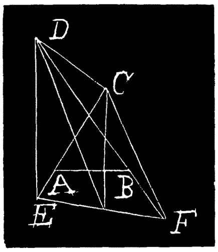
MECHANICS.

130. Proposed by W. J. GREENSTREET. M. A.. Editor of The Mathematical Gazette. Stroud. Gloucestershire, England.

Two particles are projected from A and B on the same level at α, β to horizon, and in vertical planes with which AB makes angles θ, φ. They meet and coalesce into a single particle. Find the height of the latus rectum of the snbsequent path above the level of A and B.

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics in The Temple College, Philadelphia. Pa.

Let D be the point of meeting of the two particles; mass of each, unity; C, the projection of D on the plane of AB; DE, DF, the tangents to the two paths, respectively; G, the mid-point of EF. Then DG is the direction of the resultant of DE and DF. Let $AB=a$, $\angle CAB=\theta$, $\angle CBA=\varphi$.



Then $AC=a\sin\theta/\sin(\theta+\varphi)$, $BC=a\sin\varphi/\sin(\theta+\varphi)$.

The equation to the path through AD is $m=n\tan\alpha-gn^2/2v^2\cos^2\alpha$, when $n=a\sin\theta/\sin(\theta+\varphi)$.

$$m=\frac{a\sin\theta\tan\alpha}{\sin(\theta+\varphi)}-\frac{ga^2\sin^2\theta}{2v^2\sin^2(\theta+\varphi)\cos^2\alpha}=h....(1).$$

The equation to the path through BD is $p=q\tan\beta-gq^2/2v_1^2\cos^2\beta$, when $q=a\sin\varphi/\sin(\theta+\varphi)$;

$$p=\frac{a\sin\varphi\tan\beta}{\sin(\theta+\varphi)}-\frac{ga^2\sin^2\varphi}{2v_1^2\sin^2(\theta+\varphi)\cos^2\beta}=h....(2).$$

From (1) and (2),

$$v_1^2=\frac{agv^2\sin^2\varphi\cos^2\alpha}{\cos^2\beta[ga\sin^2\varphi+2v^2\cos^2\alpha\sin(\theta+\varphi)(\sin\varphi\tan\beta-\sin\theta\tan\alpha)]}.$$

$$\tan DEC=dm/dn=\tan\alpha-gn/v^2\cos^2\alpha=\tan A.$$

$$\therefore \tan A=\tan\alpha-\frac{ag\sin\theta}{v^2\sin(\theta+\varphi)\cos^2\alpha};\ \tan DCF=\frac{dp}{dq}=\frac{\tan\beta-gq}{v_1^2\cos^2\beta}=\tan B.$$

$$\therefore \tan B=\tan\beta-\frac{ag\sin\varphi}{v_1^2\sin(\theta+\varphi)\cos^2\beta}.$$

Let velocity at D for particle from $A=u$, for particle from $B=u_1$; then $u^2=v^2-2gh$, $u_1^2=v_1^2-2gh$. Now $CE=h\cot A$, $CF=h\cot B$.

$\therefore$ $EF=h\sqrt{[\cot^2 A+\cot^2 B+2\cot A\cot B\cos(\theta+\varphi)]}=d$.

$CG=\frac{1}{2}\sqrt{[2CE^2+2CF^2-EF^2]}=\frac{1}{2}h\sqrt{[\cot^2 A+\cot^2 B-2\cot A\cot B\cos(\theta+\varphi)]}=l$.

$\therefore$ $\tan DGC=h/l=\tan C$, where C=angle of projection of coalesced particles at D. Also $DE=h\operatorname{cosec} A$, $DF=h\operatorname{cosec} B$.

$$\therefore\ \cos EDF=\frac{h^2\operatorname{cosec}^2 A+h^2\operatorname{cosec}^2 B-d^2}{2h^2\operatorname{cosec} A\operatorname{cosec} B}=\cos D.$$

$\therefore$ $\cos D=\sin A\sin B-\cos A\cos B\cos(\theta+\varphi)$.

Let w=the velocity of the two particles after they coalesce.

Then $w=\sqrt{[u^2+u_1^2+2uu_1\cos D]}$.

$\therefore$ Their path is $y=x\tan C-gx^2/2w^2\cos^2 C$.

Ordinate of vertex$=w^2\sin^2 C/2g$.

Latus rectum$=-2w^2\cos^2 C/g$.

Height of latus rectum above $D=\frac{w^2}{2g}(\sin^2 C-\cos^2 C)=\frac{w^2}{2g}(1-2\cos^2 C)=k$

Height of latus rectum above plane of $AB=h+k$.

131. Proposed by **F. P. MATZ, Sc. D., Ph. D.**, Professor of Mathematics and Astronomy in Defiance College, Defiance, Ohio.

If the distributed weight on the foundations of a building is W lb./(feet)^2, the foundations must be sunk $D=(W/w)\tan^4(\frac{1}{4}\pi-\frac{1}{2}\psi)$ feet deep in earth of density $w$lb./(feet)^3 and angle of repose ψ.

No solution of this problem has been received.

132. Proposed by **T. U. TAYLOR, C. E.**, Department of Engineering, University of Texas, Austin, Tex.

1. A parabola, whose axis is vertical, is described on the vertical face of a reservoir wall. If the vertex O of the parabola is at the bottom of the wall, and the parabola intersects the surface in the points A, B, find the depth of the center of pressure of the water on the parabolic area ABO.

2. In the same problem find the center of pressure on the area included between the horizontal line through O, a vertical through B, and the curve OB.

Solution by **P. H. PHILBRICK, C. E.**, Lake Charles, La.

The general formula for the center of pressure, is

$$\bar{x}=\frac{\int\int hx\,dxdy}{\int\int hdxdy}$$

in which h is the depth of any point below the surface.

Let O be the origin, its depth being a, and the ordinate on the surface$=b$.